NUMERICAL MODELING OF LOGIC GATE IN OPTICAL COMMUNICATION

MUHAMMAD SUFI BIN ROSLAN

UNIVERSITI TEKNOLOGI MALAYSIA

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To my beloved mother, father, lecturers,

and all my friend.

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ABSTRACT

The thesis comprehensively reviews the propagation of soliton pulse as a signal for communication. A theoretical model for the transmission of ultrashort soliton pulse is developed by numerical solution of Nonlinear Schrodinger Equation, NLSE by using Matlab programming. This study is able to demonstrate that soliton pulse can be generated as signal bit 1 and 0 as computational elementary signal. The signal produced is in the region of time domain, hence the system is compatible for the generation in the Time Domain Multiplexing (TDM) system. Linear and nonlinear directional couplers were used in fiber optics communications. The soliton pulse is based on the secant-hyperbolic model. Results show that the soliton pulse can maintain its power even after travelling for 100 km. The soliton pulse reduces its power when the Group Velocity Dispersion (GVD) parameter, β_2 is increased in the negative dispersion domain. The phase change of soliton pulse form 0 to π has shown an increase in the normalized power. However the soliton pulse exhibit chaotic behavior after a rapid increase of power at a phase of 0.8. Three models have been developed; the model of soliton code generator, soliton phase modulator, and bisoliton propagation. Two soliton input was generated inside fiber coupler and the code generator will encode its signal within the altered time difference of $\pm 0.25t$. The signal would move in the fiber coupler and the phase modulator controls the phase of the bisoliton generation from 0 to 2π. The result is the formation of optical logic AND and OR gate at the phase difference of 0.4π and 1.1π with normalized power of ~6 and parameter offset $\varepsilon=0.25$.

ABSTRAK

Satu kajian komprehensif dijalankan bagi mengkaji isyarat gelombang soliton sebagai isyarat untuk berkomunikasi. Satu model teori untuk penghantaran gelombang ultrapendek soliton telah dibangunkan oleh penyelesaian berangka Persamaan Schrodinger Tak Linear, NLSE dengan menggunakan perisian MatLab. Kajian menunjukkan bahawa gelombang soliton boleh dijana sebagai isyarat bit 1 dan 0 sebagai asas isyarat utama sistem komputer. Isyarat yang dihasilkan berada di dalam domain masa, maka sistem ini serasi untuk dihasilkan dalam sistem Pemultipleksian Domain Masa (TDM). Pengganding fiber linear dan tak linear digunakan dalam komunikasi gentian optik. Gelombang soliton adalah merujuk kepada bentuk secant-hiperbolik dan mempunyai kuasa yang stabil sepanjang 100 km. Gelombang soliton kehilangan kuasa apabila nilai parameter Serakan Halaju Kumpulan (GVD), β_2 bertambah di dalam domain serakan negatif. Perubahan fasa oleh gelombang soliton daripada 0 sehingga 2π menunjukkan peningkatan pada kuasa ternormal. Walaubagaimanapun, berlaku kacau-bilau pada fasa 0.8 apabila kuasanya meningkat secara mendadak. Tiga model telah dibangunkan; model penjana kod soliton, pembolehubah fasa soliton, dan perambatan dwisoliton. Dua input soliton telah dijana di dalam setiap input pengganding fiber dan penjana kod akan menghasilkan kod isyarat dalam perbezaan masa yang diubah (antara $\pm$ 0.25t). Dua isyarat akan bergerak dalam pengganding fiber dan pembolehubah fasa mengawal fasa di antara dwisoliton dari 0 hingga 2π. Hasilnya ialah pembentukan logik optik DAN dan ATAU pada perbezaan fasa 0.4π dan 1.1π dengan kuasa ternormal ~ 6 dan parameter pengimbang ε=0.25.